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Use of a global wave model to correct altimeter sea level estimates

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Abstract— **The study reports an assessment of global ocean wave model (Wavewatch III) outputs using altimeter algorithms wave statistics at global and regional scales. The focus is upon the sensitivity if the modeled wave moments to two distinct types of wind forcing fields, one from the NCEP atmospheric model analysis and the other from a blended product combining NCEP with scatterometer winds (QuickSCAT).**

I. Introduction

Ocean surface waves induce a bias in the satellite altimeter range measurement, the sea state bias (SSB). This SSB correction is critical for accurate altimetry measurement of sea level. To date, both theory and observations in [1]-[2] have indicated that long wave orbital velocity and short-scale wave slope variances, which are related to the second and fourth-order moments of a given wave spectrum, directly drive the SSB and its variability. The current operational SSB correction [3] relies only on the altimeter-derived wind speed U-alt and significant wave height Hs-alt. Though effective, this two-parameter SSB correction model is not entirely accurate because 1) the altimeter-derived wind is not uniquely mapped to the in situ wind, dependent on the overall sea state [4]; 2) the use of wind speed and wave height, even if accurate, does not fully parameterize the bias. One means to deal with these issues is to obtain more reliable wind measurements such as by scatterometry. Second, is to obtain measurements of higher-order ocean wave statistics to capture more subtle and physical SSB signatures. The other defining need is that such data must be contemporaneous and of high enough quality to provide information related to sea surface at the location of the fairly high resolution 6 km satellite footprint.

One potential means to gain information is through a wave model. Global ocean wave modeling has now entered an operational stage, capable of providing a full two-dimensional gravity wave spectrum that may be useful in sea state bias work. Thus, we have implemented an open source surface wind-wave model WaveWatch III, WW3 [5]. Our approach is to merge wave model, altimeter, and scatterometer data, with an overall goal being to evaluate the feasibility of combining this information to develop an improved point-by-point sea state bias range correction. As one step towards this goal, this study looks at the global and regional characteristics of wave model spectral parameters and their sensitivity to changes in the wind forcing fields.

IV. Summary

This study reports an altimeter-based evaluation of wave model (Wavewatch III) parameters, including Hs, Tm and Mss from low to high order moments at both a global scale and regional scales. One focus is on the sensitivity of the high-order moments to two distinct types of wind forcing fields, NCEP model winds and the blended winds products using scatterometer (QuickSCAT) and NCEP model wind analyses. On a global scale, we have found WW3 model wave parameters accords with altimeter derived ones. In different regions with different wind-wave environments, the model wave parameters compare with altimeter parameters differently. For high sea state cases (high latitude regions), the model parameters calculated by WW3 runs driven by NCEP and NCEP/QSCAT winds match very well, and also accord greatly with altimeter-derived parameters. Their sensitivity to wind forcing seems. In the cases of low sea states, the difference between the two model products from NCEP and NCEP/QSCAT winds is significant, particularly for Hs and Mss, but is very small for Tm, suggesting that Hs and Mss is quite sensitive to winds, but much less sensitive for Tm. It is important to note that modeled Mss-NCEP appears unreasonably low for this case. The sea state bias in this region is fairly significant. Special attention may be required in this context.

Logically, the altimeter comparison approach in this work is, at minimum, independent since WW3 model wave parameters (Hs, Tm and Mss) are determined without access to any altimeter assimilations. The altimeter wave parameters are retrieved using routines tuned to NDBC buoy data (ground truth, but certainly not global). Still, from a global view, the model-estimated Tm is consistent with altimeter-derived values. Once viewed separately in high-latitude and equatorial regions, the distinguishing features of the pdf patterns of WW3-derived Tm (and Mss) with respect to altimeter-estimated ones are noticed in the two regions where wind wave climates are different. A further investigation into these distinguishing features is needed to understand if there is geophysical meaning behind the feature differences in different regions. Initial looks suggest that excessive swell generated at higher latitudes using the NCEP/Quikscat winds is responsible for much of the WW3 model disparities at the lower latitudes.